



# Carbon Footprint of Movie Production Location Choice: the Real Cost

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Carbon Footprint of Movie Production Location Choice: The Real Cost

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A Thesis in the Field of Sustainability and Environmental Management  
for the Degree of Master of Liberal Arts in Extension Studies

Harvard University

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## Abstract

The film and television sector is the number one industry contributor to Los Angeles air pollution (University of Southern California, 2006). Yet, 39 states and many countries offer film incentives, in a quest to lure film productions to locations outside of California. These incentives have been successful at convincing film productions to leave California. In 2013, there were 108 major feature films produced by the six largest studios in Los Angeles, but only 15 of those productions were kept in California (Film L.A., 2013).

Studios are willing to add the multitude of logistics and financial resources necessary to take film production out of California because the financial incentives to do so can be higher than 50% of the relocated production budget, far exceeding the additional cost. However, the studios, and the states and countries offering millions of dollars to the productions, are not considering the carbon impact when transporting film production. My research compares the greenhouse gas (GHG) emissions of a Los Angeles based studio production shot in Los Angeles, Boston, and Vancouver, Canada. The objective of this research is to provide sustainability information that is needed to inform studios, states and countries considering film incentives of the complete cost of the incentives. I hypothesized that transferring production to cities outside Los Angeles results in substantial hidden environmental costs in added GHG emissions.

An actual \$71.7 million dollar film production plan was used to calculate the carbon costs for three various production locations. Transportation used for the shoot was categorized by air transportation and shipping. Air transportation was then analyzed

to determine the number of round trip flights per shoot location, and then greenhouse gas calculations were run to determine the carbon footprint for these flights. Greenhouse gas emissions for shipping were also calculated per production and the greenhouse gas calculations were run. The flight and shipping greenhouse gas calculations were then totaled per location. Last, the emissions were monetized.

These analyses showed that flights of the cast and crew, and shipping of goods for a production shot in Boston, can have five times the greenhouse gas emissions as the same production being shot in Los Angeles. Since Vancouver is an established film production market, a Vancouver production results in less flight segments, shipping, and thus less greenhouse gas emissions than Boston, but it is twice as much as a Los Angeles production. This research can show film studios the carbon footprint implications of “runaway” (films produced outside of California) productions, at a time when consumers are becoming increasingly interested in corporate sustainability. Moreover, it will inform film incentive policy makers by highlighting the carbon footprint that comes with importing film production from California.

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## Chapter I

### Introduction

The film and television sector is the number one industry contributor to Los Angeles air pollution (University of Southern California, 2006). Yet, 39 states and many countries offer film incentives, in a quest to lure film productions to locations outside of California. These incentives have been successful at convincing film productions to leave California. In 2013, there were 108 major feature films produced by the six largest studios in Los Angeles, but only 15 of those productions were kept in California (Film L.A., 2013).

### Research Significance and Objectives

This study will provide states with film incentives, or those considering film incentives, the “cost” of the added carbon footprint being brought to the area resulting from their incentive to lure the film industry. In addition, understanding the impact a film’s production location has on the carbon footprint it engenders, allows film studios to consider environmental sustainability, in addition to financial savings when considering production locations.

My primary research objectives are:

- To evaluate the carbon footprint comparison of flights and shipping of one film produced in various locations for studio practices.
- To advise on policy where film subsidies (incentives) are offered or being considered.

## Background

Environmental and social sustainability is a necessary part of the corporate world. While financial sustainability is easily tallied, the environmental and social sustainability costs and benefits can have just as large of an impact on a corporation.

Consumers are increasingly aware of corporate sustainability. Unsustainable practices create a liability for a company with internal and external stakeholders. If a company makes decisions based on financial sustainability alone, a company is risking environmental and social sustainability. By ignoring environmental and social stakeholders, the overall sustainability of a company is reduced.

Corporations can decrease their carbon footprint by changing business practices or by a combination of changing business practices and participating in carbon offsetting. Consumers are confused by the value of carbon offsetting, as transparency and lack of standards are not prescribed (Dodds, Bessada, Garcia, McDougall, Thieson, 2012). While the value of carbon offsetting may be vague to the consumer, a corporation's carbon footprint is clear.

## Sustainability Reporting on Carbon Footprints in the Film Industry

The top six film production companies (20<sup>th</sup> Century Fox, The Walt Disney Company, Paramount Pictures, Sony/MGM, Time Warner/New Line, and Universal Studios) are based in California. These top six film production companies in the Los Angeles market have a myriad of divisions responsible for entertainment and merchandising in the Los Angeles market, and worldwide. The top six studios are also the producers of large budget films.

The movie studios all have sustainability departments and efforts. There is no consistency amongst the studios as to which sustainability data are gathered or shared. The sustainability efforts and data available on each studio site are cumulative by company, business unit, or geographic boundaries. The sustainability reports do not break out “film production” nor do the reports show sustainability data regarding individual films. Furthermore, while studios are incorporating sustainability practices in to their business, there is no transparency or industry standard for sustainability practices (Harris, 2014).

#### Carbon Footprints by the Six Major Studios

Below are a few highlights of each of the studio’s sustainability efforts:

*20<sup>th</sup> Century Fox.* Rupert Murdoch published a letter on the company website stating “21<sup>st</sup> Century Fox” is carbon neutral, across all global operations (Murdoch, 2011).

Then, in the 2014 carbon report, there is no mention of “carbon neutral”. The carbon reported, summed across scope 1, 2 and 3, is 239, 943 metric tons (21<sup>st</sup> Century Fox, 2014). The sustainability of the feature film division highlights many social sustainability programs, with very few mentions of environmental strategies for the film division (21<sup>st</sup> Century Fox, 2014).

*The Walt Disney Company.* The Walt Disney Citizenship Report reports the company has met the set benchmarks toward achieving its long-term goal of zero net greenhouse gas emissions, as well as meeting many of its consumption and waste goals (The Walt Disney Company, 2014). The Walt Disney Company had carbon emissions of 915,764 metric tons, with retired carbon credits of 457,882 leaving a net direct emissions balance

of 457,822 in 2013 (The Walt Disney Company, 2014). Prior to the use of carbon credits in 2012, the Walt Disney Company had carbon emissions of 710,459, which shows a major increase of 29% in emissions in two years (The Walt Disney Company, 2014). No information was found regarding film production specific environmental practices.

*Paramount.* In researching Paramount Pictures, no sustainability report is found. There is a statement that the company follows all laws, and there is a section on social responsibility, in regards to tobacco being shown in films, but no carbon-based or environmental sustainability reporting was found (Paramount Pictures, 2015).

*Sony Pictures.* Sony became zero waste in 2011, and has cut carbon emissions by over 20% since 2006 (Sony, 2014). Sony calculates the carbon footprint of each film, and enforces green practices on each production (Sony, 2014). In 2013, Sony had emissions of 1,295,817, (43,082 from the movie division) with offsets of 64,746, with a goal of a zero carbon footprint by 2050 (Sony, 2014). However, the carbon footprint of each film is not made public.

*Time Warner.* Warner Bros. feature films have released seven films as “carbon neutral” stating carbon credits as the method to achieve the status (Time Warner, 2014). Carbon calculators are used for each film (Time Warner, 2014). The carbon footprint could not be located in the corporate reports, nor were the results from the carbon calculations of any of the films.

*Universal.* Film production guidelines are used for each production, which include practices such as recycling water, and recycling or donating production goods, through utilization of “The Green Production Guide” (Universal, 2014). When shooting “Dr. Seuss’ The Lorax” the actors were recorded in ten different locations, over two

continents, and the shoots were compiled digitally without the immense air travel that would have been needed to record in one location (Comcast, 2013).

#### Studios Efforts to Decrease Return Shipping and Landfill Rates

In 2014, studios announced 19,000 tons of solid waste, including studio sets, was averted from landfills, resulting in a 75.5% landfill diversion rate (Motion Picture Association of America, 2015). The studios have different ways of targeting reuse and recycling of film production items: below are examples of the efforts (Motion Picture Association of America, 2015):

- Disney ABC Studios rents set materials to other studios, which gives Disney a new revenue source, keeps those renting from recreating existing sets, and keeps those materials from ending up in landfills.
- Twentieth Century Fox has a program to recycle and donate props and costumes, which means less return shipping.
- NBCUniversal maintains their sustainable practices while producing in Los Angeles or anywhere in the world. The practices include recycling and reusing, donating and using Forest Stewardship Council certified lumber, if available.
- Sony Pictures' Columbia and Screen Gems plant trees for each day they are filming on location outside of Los Angeles to offset its greenhouse gas emissions.
- Warner Bros. Entertainment attempts to find local market use for production items. For instance, when filming "Batman v Superman" parts of the set were used to construct bat houses, bringing awareness to the issue and finding a reuse purpose for the set.

There are also many individuals in the film business who are interested in decreasing their industry's carbon footprint. Some, such as Leonardo DiCaprio, Matt Damon, Ben Affleck and many others, have discussed their opinions publicly. However, when considering film production, the industry norm is still to consider financial, regardless of the other "costs."

#### Film Production Life Cycle Analysis/Carbon Footprint

Little, if any, life cycle analysis is available on film production. Some studios claim to calculate the carbon footprint of films, but the information is not accessible to anyone outside of the studio gathering the information. There are a handful of films, such as "An Inconvenient Truth," which claim to be carbon neutral (Paramount Classics, 2006). "An Inconvenient Truth" obtained its carbon neutral status by buying carbon credits to offset the carbon footprint of the production, however, the film did not change the industry norm production practices (Paramount Classics, 2006).

When attempting to determine a movie production's carbon footprint, it may either not be publically available or it may not be computed internally at the movie studios. Further, production plans, which outline individual budget line items for the production, are extremely confidential. The confidentiality of production plans is not due to the carbon footprint information, which could be derived from the plans. It is due to the competitive nature of the film industry, and the talent within the industry. It is not possible for outside stakeholders to calculate a film's carbon footprint without specific production plans. The studio's lack of desire to share its budget detail could be one



reason why I found no study when researching for current footprint information in film production.

The mystery surrounding the carbon footprint of film production widens when the productions are taken out of state or out of the country. The carbon footprint that is confined to California, when films are produced in the Los Angeles area, is taken to other locations when the filming leaves the area. The “runaway” (the industry name given to productions leaving California) productions increase the carbon footprint by the need to increase logistics, human travel, cargo shipping, etc.

If there is quantifiable knowledge regarding the carbon footprint of film production, states and other countries may be less likely to offer such immense incentives to the film studios. Those involved in the production may begin to ask questions regarding the decisions impacting the footprint. Sustainability changes made to decrease the carbon footprint could helpfully ensue. But how large is a film’s added carbon emissions from moving production locations outside of Los Angeles? We would need to examine a case study using the detailed production budget to determine this.

Each film has a large variance in production. The number of cast, crew and executives requiring location flights depends on the talent level and budget. The amount of people on a film can be very large as was the case for Iron Man 3, which has over 3,000 cast and crew credits listed on IMDB (IMDB, 2016). A portion of the cast and crew would have been employed locally, however, many of the 3,000 would have been needed on the production site.

The amount of goods shipped for a film production includes costumes, make-up, props, set design, equipment, film, and any other items that are required for consistency

in filming. As with flights, the amount of goods shipped varies per film. For instance, a period piece film may require more tons of shipping than a present day drama. Even the amount of props can impact the shipping. In “The Chronicles of Narnia: Prince Caspian,” over 7,000 props were used (Finances Online, 2014). No matter how many props were needed for an incentive shoot, large number of props would have been shipped. The props shipped would have been one category of actual shipping. The tons shipped vary per location. Boston and Vancouver require the shipment of goods for consistency in production, while Los Angeles has access to most goods onsite, requiring very little shipping. What is not shipped back to the studios has the potential to become landfill.

#### Incentives to Produce Films in Alternative Areas

Figure 1 shows the film and television industry has the highest output of conventional pollutants, exceeding the aerospace industry, in the Los Angeles metropolitan market (Corbett, Turco, 2006). Yet, the film and television industry is offered extensive financial incentives to move their productions to various locations outside of California.

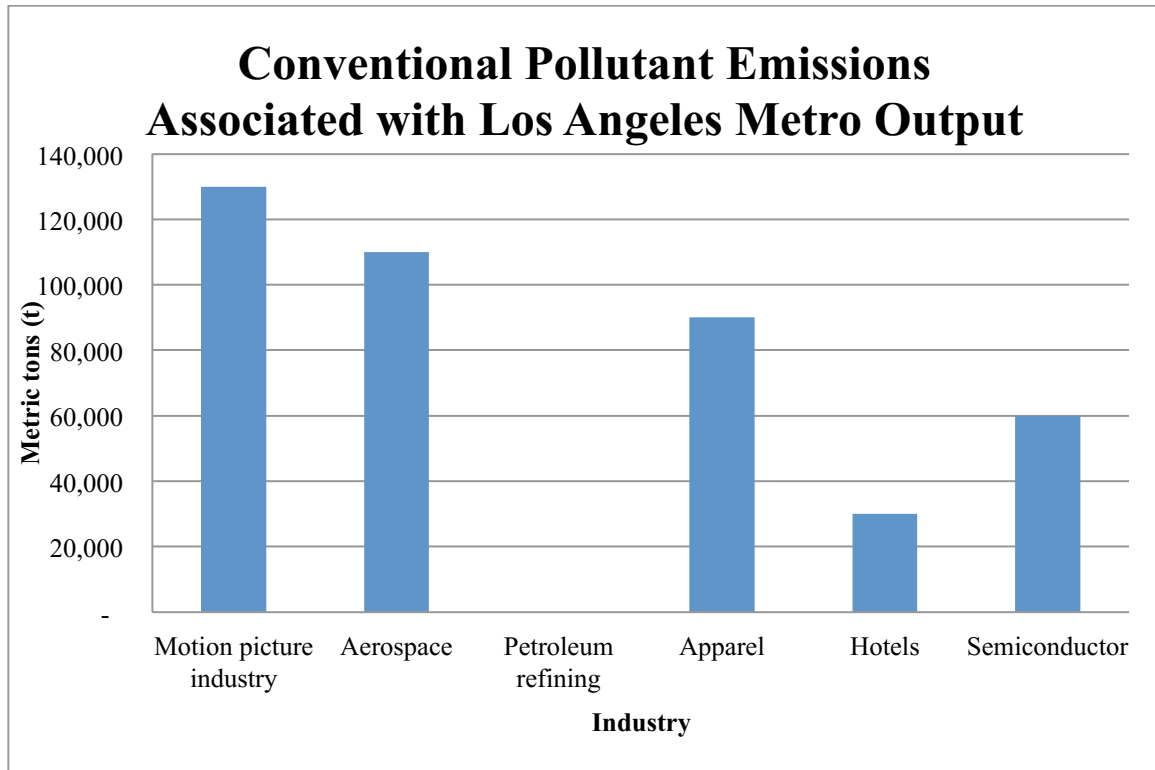


Figure 1. Conventional pollutant emissions for selected sectors within the Los Angeles metro area (Corbett, Turco, 2006).

The film and television industry has increased its awareness of environmental issues as witnessed in Figure 2 by the increase in environmental articles from the industry's trade publications (Corbett, Turco, 2006). The increased awareness takes place at the same time the film subsidies become a "business as usual" occurrence.

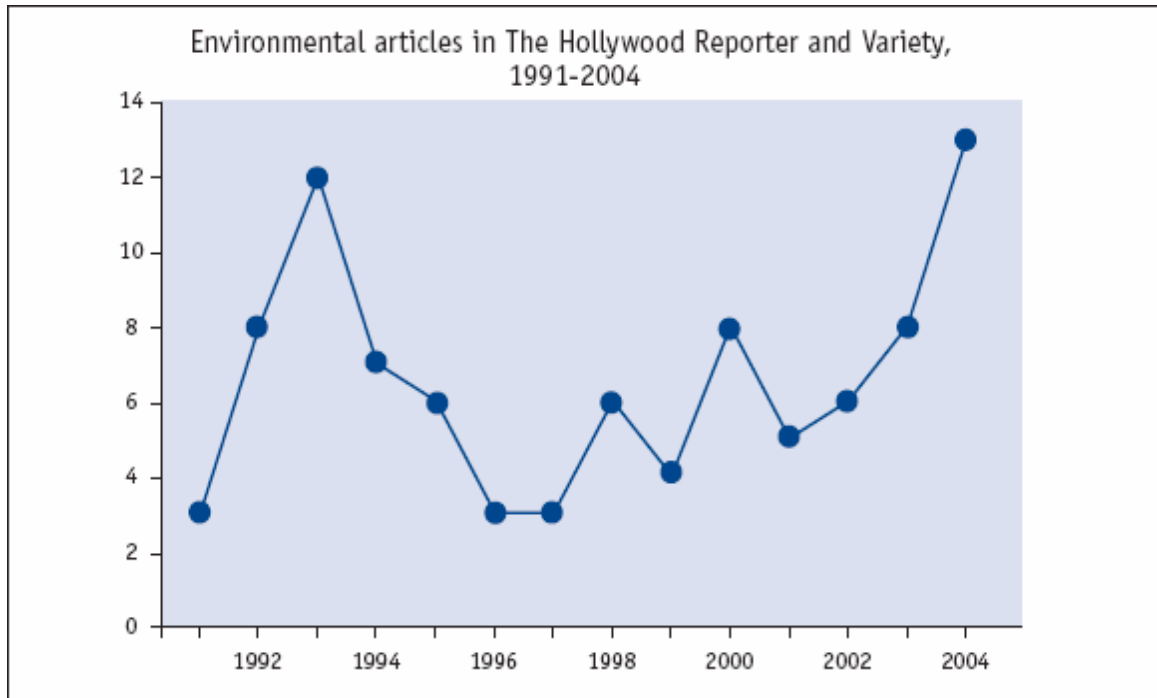


Figure 2. Environmental articles in film trade publications (Gathered by Corbett and Turco, UCLA Institute of the Environment and Sustainability).

### State Film Incentives

There are 39 U.S. states currently with film production incentives. Film incentives have increased each year. In 2011, the incentive amount offered for one year totaled almost \$1.3 billion dollars (Table 1) (McDonald, 2011).

Table 1. State film incentive programs and dollars offered.

Year	Number of States with Film Incentive Programs	Incentive Amounts Offered
1999 & earlier	4	\$2 million
2000	4	\$3 million
2001	4	\$1 million
2002	5	\$1 million
2003	5	\$2 million
2004	9	\$68 million
2005	15	\$129 million
2006	24	\$369 million
2007	33	\$489 million
2008	35	\$807 million
2009	40	\$1.247 billion
2010	40	\$1.396 billion
2011	37	\$1.299 billion

Table 2. State film incentive overview.

<b>State</b>	<b>Incentive</b>
<b>California*</b>	20% tax credit, with \$75 million cap of eligible production budget
<b>Massachusetts**</b>	25% production credit, 25% payroll credit, sales tax exemption
New Mexico	25% on all direct production expenses, with additional 5% for minimum soundstage usage
Georgia	20% tax credit
Michigan	32%, going to 27% in 2015, Michigan personnel expenditures Direct production expenses of 15-27%
New York	30% tax credit
Utah	Rebate of 20-25%
Louisiana	30% income tax credit
North Carolina	25% tax credit
Maine	10-12% wage tax rebate Additional 5% tax credit for non-wage
Maryland	25-27% tax credit
Illinois	30% credit Additional 15% for individuals from economically disadvantaged areas

(California Film Commission, 2015) \*\* (Massachusetts Film Office, 2015)

Table 2 offers a broad sampling of the incentives across states (National Conference of State Legislatures, 2014). To illustrate the potential financial impact of the film incentives, consider a \$100 million dollar film being shot in Boston, Massachusetts. Assuming the whole \$100 million was spent in Boston, the production would not pay any sales tax. The studio would also receive a check for 25% of payroll and production costs (Massachusetts Film Office, 2015). If the total \$100 million had

been spent on production costs and payroll, the studio would receive a \$25 million dollar check. If that same film was produced in California, the film incentive opportunity is not as beneficial.

The California Film Commission only “has the authority to allocate \$100 million dollars of tax credit each year” (California Film Commission, 2015). In addition, through 2015, California has a \$75 million dollar cap for a single film (California Film Commission, 2015). With feature film production budgets commonly over \$100 million per film, the California film incentive program does not provide opportunities for major budget productions.

California has just recently changed its incentive to lure films back to production in California: the state incentive is now the first \$100 million dollars of a production, versus the previous cap of \$75 million (California Film Commission, 2016). The incentive allows for a 20% credit, but gives an additional 5% incentive if the production occurs outside the Los Angeles 30-mile zone (California Film Commission, 2016). The additional 5% incentive is to take production to other parts of California, which requires the transportation of people and goods to those locations. The incentive to have productions travel outside the 30-mile radius of Los Angeles does not take environmental issues into account.

#### Out of Country Film Incentives: Canada

Other countries also attempt to get Hollywood to bring productions to their location. Many are successful at having a portion of a film produced in their country, but Canada has enjoyed the most success. Approximately 75% to 80% of Hollywood

productions taken out of the United States go to Canada (Ware, 2006). Canada was an early adopter of the film incentives. Canada now has very experienced cast and crew, furthering the comfort for studios to take productions out of California. In the United States, film positions are focused to one area. In Canada, a person can hold various positions. Therefore, in Vancouver, a person could be both a set designer on one film and a costume designer on another film. This gives the talent pool more opportunity to work on more film projects. Since the film production team can work in various positions, they are employed more than if they are only capable of one skill set. The ability to stay employed results in experienced workers in the local market with less people needed from outside of the market. The experienced market is coupled with financial incentives, which motivates the studios to shoot in Canada. Canada offers incentives greater than those of any of the states in the U.S. (Table 3).

Table 3. Canadian film incentives.

<b>Qualified Incentive Category</b>	<b>Incentive</b>
Combined federal and provincial programs	<b>37-70% eligible labor tax incentives</b>
Various provinces	Bonuses in addition to the tax incentives
Local spending	25-30% tax incentives
Federal tax credit	16% of Canadian labor

(Canada Film Capital, 2014)

Canada's incentives began in 1997, prior to the incentives in the United States (Canada Film Capital, 2014). Canada is also unique compared to the U. S. state



incentives in that the incentives require greater local human resource and physical resource usage. The result is that areas of Canada have become experienced in film production. This allows the movie studios to both save on budget by taking less human resources and goods from L.A. to Canada, as well as have the advantage of working with people who are trained and skilled in film production. In 2014, Canada had film and television production of \$5.81 billion annual revenue, with more than 127,700 people being employed by the industry (PWC, 2015).

A film produced in Vancouver, Canada, could potentially be awarded a 25% federal tax credit for labor cost, 16% federal tax credit for all Canadian labor and 35% British Columbia tax credit for permanent residence labor, in addition to various regional credits (PWC, 2015). Given the wide range of credits available, the difference of shooting a production in California in comparison to shooting the same production in Vancouver, California, is best exemplified by a quote from Vans Stevenson, Senior Vice President of Government Affairs, at the Motion Pictures Association in 2014 (Film L.A. 2013):

Let's say the gross total budget of a big tent-pole is \$251 million. If you take that film to Vancouver, for example, that same picture before credit would be \$259-\$260 million. You've got the (extra) cost of hotels of housing for cast and key crew you bring from L.A., as well as people you hire on the ground. But the incentive there is worth about \$18 million. So you're reducing that budget from \$251 to \$241 million. That's a big savings.

#### Film Incentive Impact on States

States provide the incentives to film productions in hopes of creating jobs and increasing tourism. This comes with much controversy. Adversaries call in to question the permanency of the jobs created and the cost of the jobs created, given the incentives.

Any film production is transient. Jobs created may be temporary or result in no employment between productions. The Department of Revenue for the state of Massachusetts determined it cost the state \$108,000 per local job created from the film incentive program (Newsham, 2014). The year prior, the Department of Revenue found approximately 40% of incentive dollars go to out of state executives, actors and crew (Annear, 2013). However, the Motion Picture Association of America conducted a study, which showed Massachusetts generated \$375 million for the \$38 million in tax incentives (HR&A, 2013).

While California has seen decreases in film jobs, many states have reported increases. Reports of such increases vary widely, as there is much controversy regarding the film incentives. An Ernst and Young study, commissioned by the Motion Picture Association of America, found that a \$10 million dollar production could increase employment for a state, generating approximately 37 full time jobs and an additional \$900,000 in employee compensation could be credited for a \$10 million dollar production (Phillips, Cline, Fox, 2012).

#### Current Location Production Practices

In 2013, out of 108 major films produced by the top six film production companies, 15 were filmed in California, with the remainder filmed out of state or out of the country (Film L.A., 2013). There are numerous reasons a movie studio will take film production to another state or country. First, budget is the number one reason a film is made outside of California: even though filming outside of the Los Angeles area increases the cost of shipping and transportation of people and goods, financial incentives

given to movie studios by states and countries more than make up for that. Second, there is creative variability. The creative arm of the production may think there is a need for a specific geographic area. Regardless of the creative team's desires though, it still goes back to budget. As Paul W. S. Anderson said of his "Aliens vs. Predator" film, "Just to build the sets, the construction budget, just for the sets alone, if we had done the sets in L.A., it would have cost 20 million dollars; to do it in Vancouver, it was 15, to do it in Berlin it was 5 million and we built exactly the same sets in Prague for 2 million dollars" (Anderson, 2003).

When a studio is considering the decision to shoot in another state or country, the production "shops" the project. The states and countries vying for the opportunity to have a production in their state/country are convinced the dollars spent on the incentive will be worth the investment. After the numbers are crunched, studio management approval is sought, and then a location is chosen. However, the numbers approved by the management team are financial numbers. Carbon footprint numbers are not part of the business as usual decision-making process.

### Research Questions, Hypothesis and Specific Aims

States need to have all of the facts surrounding the implications of state film incentives. In order to do so, in addition to the financial implication of offering a film incentive, the state also needs to consider further costs to the state. The costs need to include the carbon footprint left by the film productions.

An analysis, using one individual film, that directly compares film production location choices against the carbon footprint, is needed to inform studio production

decisions and film incentive policy. My research will therefore compare the carbon footprint of the same film produced in Los Angeles versus Boston versus Vancouver.

My research will examine two related questions:

1. What are the consequences in terms of net greenhouse gas emissions of producing Los Angeles studio films, outside of Los Angeles?
2. How should governments alter their views of their film incentive policies if they take into account these indirectly increased greenhouse gas emissions?

In addressing these questions, I intend to test the following two hypotheses:

1. Studios would increase environmental sustainability by keeping film production in the Los Angeles market, rather than producing films outside the Los Angeles market.
2. The cost of the carbon footprint of films being brought to states and countries through film incentives decrease the environmental sustainability of the programs.

Examining these hypotheses requires addressing these specific aims:

1. Utilize a model for carbon calculation.
2. Categorize Hollywood film production plan/budget by number of flights and shipping.
3. Compute the carbon footprint of flights and shipping for one film, based on production of the film being in three different locations.
4. Determine the lowest carbon footprint of the three production locations.
5. Monetize the metric tons (t) of CO<sub>2</sub>e for flights to and from each location.

## Chapter II

### Methods

A spreadsheet model was created to compute the flight and shipping carbon footprint value of each production scenario. Each budget line item of a production was categorized as flights or shipping “impacted by the location change, or “location has no impact.” The “flight” and “shipping” line items were lumped into summary line items to create a minimum number of calculations. For instance, travel by all persons from a specific location can be treated as total trips from this location. Another example is that cargo shipped is treated as its combined weight.

### Research Design

The distance from Los Angeles to Boston, and from Los Angeles to Vancouver was calculated. Mean distances for flights originating outside of Los Angeles, going to and from all three markets were also estimated. Depending on the hire, the round trip flight could be from any city inside or even outside the country. St. Louis, due to central location in the country, was used to calculate the distance for flights not originating in Los Angeles. When comparing Los Angeles to the other two markets, 5% of Boston flights were assumed, due to a leaked report by Walt Disney, which showed Los Angeles has approximately 5% of the travel budget, when compared to Massachusetts and Vancouver (Walt Disney, 2009). Each production scenario utilized the same number of flights in the calculations across the three locations, although the distances varied. The

total number of flights were categorized, by “coach”, “first class” and “private jet,” and totaled per destination. The calculations used for the “base” film are then extrapolated over the three locations, based on the budget. For instance, as the budget decreases, it is assumed the amount of travel will decrease in the same proportion, and similarly for the budget increases. The greenhouse gas emissions were calculated for each class of flight for Boston, Vancouver and Los Angeles.

Shipping cargo was analyzed by amount of weight shipped for each production scenario. The weight shipped was calculated by taking the budgeted dollar amount for shipping and assuming an average shipping time of three days. The published rates for FedEx were used to determine the amount of pounds shipped (FedEx, 2016). The rates were not discounted, therefore resulting in a conservative calculation of actual pounds shipped. Large companies, including film studios, receive discounts from the published rates. The shipping calculations do not include any discount in the rate, resulting in a lower weight than was actually shipped. Therefore, it can be assumed that the weight of the approximately \$75 million dollar production, and the weight proportionately assigned to the various budgeted films, is potentially lower than the actual budgeted amount of pounds shipped.

On average, approximately 50% of goods shipped to a location can be expected to have return shipping to Los Angeles (Anonymous, 2016). Therefore, a 1.5 multiple was used in calculating the shipping. The greenhouse gas emissions were calculated on the total weight shipped. Just as with flights, the calculations used for the “base” film are then extrapolated over the three locations, based on the budget. For instance, as the budget decreases, it is assumed the amount of shipping will decrease in the same

proportion, and similarly for the budget increases. The greenhouse gas emissions were then combined for a total of flight and shipping t CO<sub>2</sub>e.

In addition, I consulted an industry executive to verify travel and shipping data derived from the line item production budget. The executive was told to use industry knowledge to determine what would be an industry norm when producing a \$75 million dollar motion picture. The industry executive verified the general data of the following:

1. Number of people taking flights.
2. How many flights were taken.
3. Which class the passengers flew.
4. The weight of the cargo shipped.
5. How much of the cargo was returned shipped.

#### Assumptions about Flights

Using a film with a budget of approximately \$75 million, 110 individual round trip flights are indicated in the line item assessment when considering the production site locations of Boston (Smoking Gun, 2003). Of those 110 flights, 77 were budgeted to travel “coach” and 33 were budgeted as “first class” flights. There were an additional three round trip flights budgeted as “corporate jet” flights.

As the budget of a film decreases, the assumption is the number of flights will decrease in approximately the same proportion. As the budget of a film increases, the assumption is that the number of flights will increase in approximately the same proportion. For instance, a smaller budget film of \$1 million dollars may only fly in three individuals for production. Meanwhile, a big budget film may have 600 round trip

flights, or more because all flights are not accounted for in the line item budget.

Investors may take a private jet service or commercial air service to visit the production, but that is not represented in the analyzed budget. Also, a contractor may take many flights to and from the production site, but that also would not be itemized in the budget, as it is part of a total lump sum number allotted to the contractor for their services. Last, the film budget does not have line items for family members. The flight numbers listed are based purely on the known budgeted flights, resulting in a conservative analysis, without the total number of flights associated with the production reported.

### Methods of Analysis

The following steps were followed in conducting the research:

1. I created a spreadsheet model, which allowed for calculation of flights and shipping for each film location. Each line item was input, and a formula calculated the carbon footprint. For instance, when calculating the personnel travel from Los Angeles to a production in Boston, one round trip flight was input into “calculator.carbonfootprint.com” (Carbon Footprint, 2015). The carbon footprint for one flight was multiplied by the total number of flights for the production. The calculations were repeated for each class of flight service. For shipping, the beginning and ending location and the weight of the shipments was input in to the carbon calculator on “ClimateFriendly.com” (Climate Friendly, 2015). The process was repeated for each location scenario, based on industry norm percentage of flight and shipping changes, due to a location having a deeper infrastructure (Disney, 2009).



2. The Hollywood production, “The Village”, with an approximate production budget of \$75 million dollars and 3-4,000 budget line items for the location calculations, was used as a case study for flight and shipping information (The Smoking Gun, 2006). Each line item of the Hollywood budget production plan was manually categorized for flight and shipping. For shipping, best efforts were used to determine average weight of industry equipment, staging, and goods shipped, based on the production budget.
3. The numbers calculated above were then put in to the model to calculate the flight and shipping carbon footprint, by category for a Boston production. Flight and shipping were totaled for each film scenario footprint. The second time, the carbon calculations were run as though film is being shot in Vancouver, Canada. Again, the model calculated a carbon footprint output per flight and shipping categories. The categories were totaled for the film’s travel and shipping carbon footprint. Last, the carbon calculations for travel and shipping were calculated for the same scenario production, produced in Los Angeles, California and the categories were totaled for the film’s flight and shipping carbon footprint.
4. I used the base film flight and shipping totals to run projected flight and shipping totals for films with budgets of \$1 million to \$400 million.
5. Comparison of the flight and shipping for the three film locations, using flight and shipping carbon emissions, was calculated. Locations were ranked, based on the least carbon emissions first, and the most carbon emissions last.
6. A sensitivity analysis of various travel and shipping values was conducted to exhibit greenhouse gas emissions for different production scenarios. For instance, if a production uses more local personnel or obtains more goods locally than the film

analyzed, the implications are shown. However, if a film uses more personnel from outside of the local market and ships in more goods than the film analyzed, the implications are shown.

7. The greenhouse gas emissions were monetized, using the social cost of carbon, as a portion of the cost of subsidies for films. The social cost of carbon is intended to give a dollar value to the effects of each additional t CO<sub>2</sub>e. The Environmental Protection Agency states (EPA, 2016):

The SC-CO<sub>2</sub> is meant to be a comprehensive estimate of climate change damages and includes changes in net agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning.

The United States Government has assigned a value of approximately \$37-\$38 per each t CO<sub>2</sub>e to calculate the impact from the release of the CO<sub>2</sub>e (EPA, 2016). However, there is controversy that the \$37-\$38 number does not account for actual impact, or cost of living increases. The EPA itself suggests the number is not accurate (EPA, 2016):

However, given current modeling and data limitations, it does not include all important damages. The IPCC Fifth Assessment report observed that SC-CO<sub>2</sub> estimates omit various impacts that would likely increase damages. The models used to develop SC-CO<sub>2</sub> estimates, known as integrated assessment models, do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research.

Research conducted by scholars at Stanford University has shown \$220 per each t CO<sub>2</sub>e is a more accurate value (Moore & Diaz, 2015). This integrated assessment model used by Moore and Diaz has been endorsed as a method to analyze the cost and benefits of carbon emissions (Than, 2015). Therefore, monetary “costs” of the t CO<sub>2</sub>e are shown as \$220/t CO<sub>2</sub>e.

## Chapter III

### Results

Figures 3, 4 and 5 show the variation of round trip flight segments based on budget size of the film. Not surprisingly, in all three locations, as the budget increases, so does the total number of all three classes of flight segments.

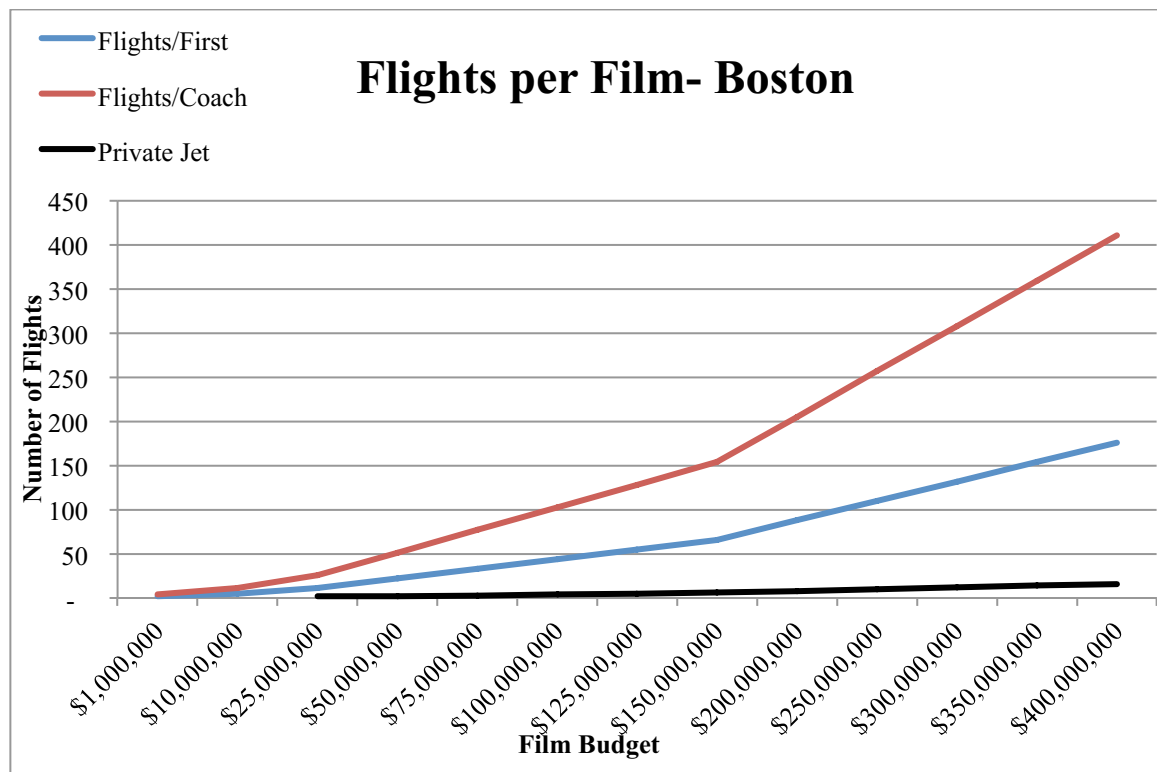


Figure 3. Projected flights for Boston production.

The Boston production site has less flights budgeted from Los Angeles than many other production sites would warrant, due to the talent pool in New York. Many of the needed personnel can be hired out of New York City, which decreases the budget. It is

assumed all persons flying from New York used coach flight service. A film with a \$300 million dollar budget results in over 300 round trip coach flights and has approximately 130 round trip flights (Figure 3). Private jet usage is valued at 12 round trips for senior production executives.

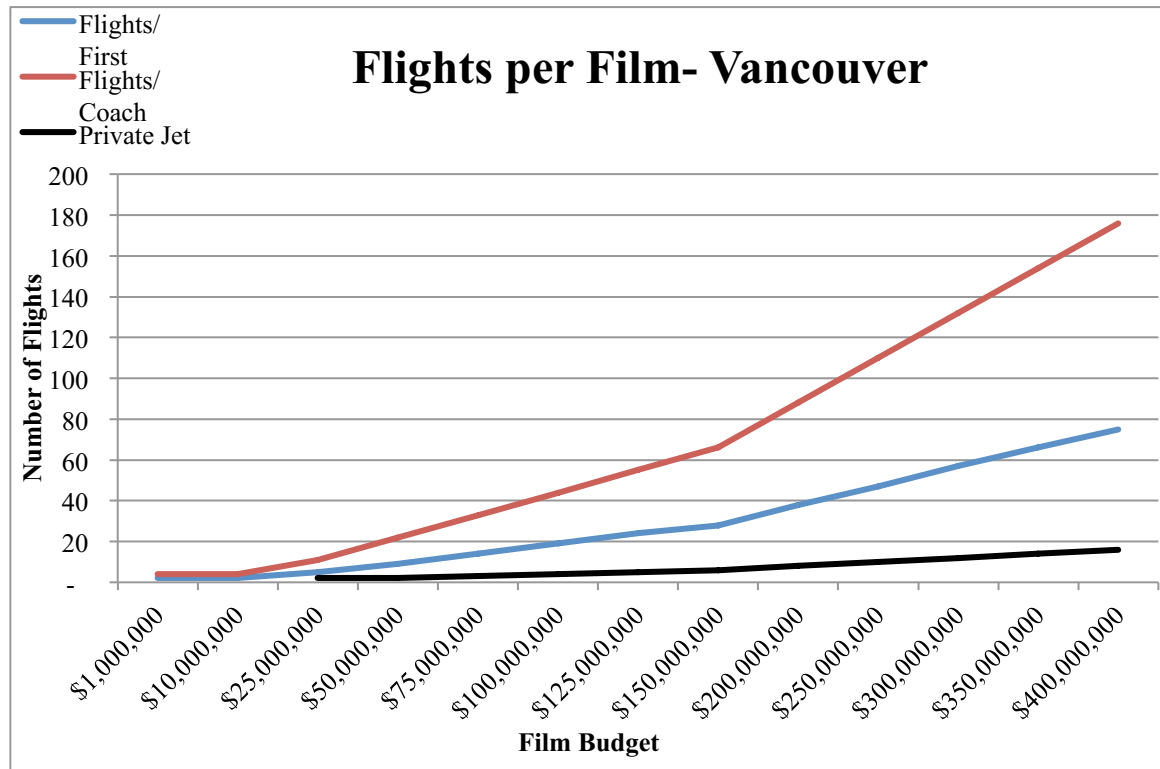


Figure 4. Projected flights for Vancouver production.

The Vancouver production site has many less flights budgeted than Boston due to the mature filming community in place. Producers can utilize personnel from Vancouver for many positions normally hired out of Los Angeles. Therefore, a \$300 million dollar production has 132 coach flights and 57 first class flights projected, both far less than half of Boston flight segments (Figure 4). There are 12 round trip private jet flights due to corporate executive travel.

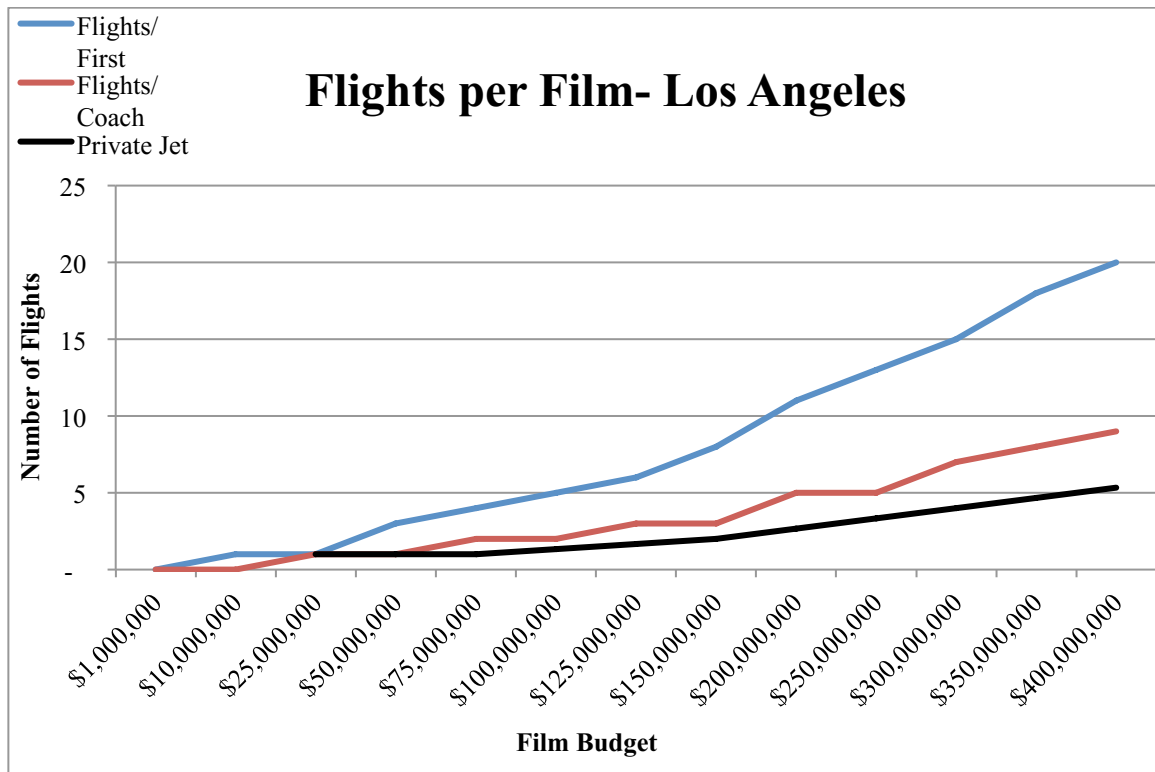


Figure 5. Projected flights for Los Angeles production.

Filming in the Los Angeles market results in less budgeted flights than the Boston and Vancouver markets (Figure 5) due to the deep talent pool of all film production positions. The major production studios are based in Los Angeles so most of the executives, crew and talent, are in the local DMA. The flights for the Los Angeles market are due to the executives, crew and talent who live outside of the market. Those flights are a combination of New York round trip flights and an average of “other” round trip flights of people hired who live in areas outside of Los Angeles. There are 15 coach round trip flights, 7 first class round trip flights and 4 private jet round trip flights for a \$300 million dollar budget film. The reason there are still any flights budgeted is due a portion of highly coveted talent living outside of the Los Angeles market.

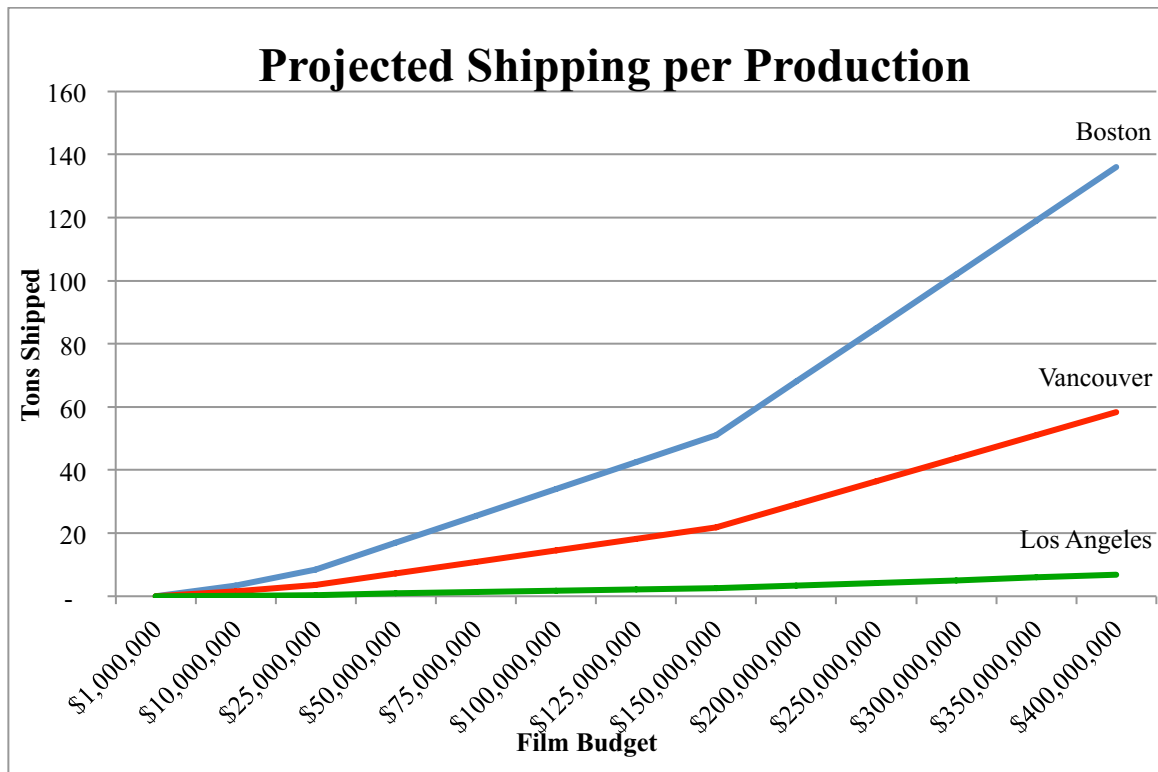


Figure 6. Projected tons of shipping per production location.

A \$300 million dollar film production shooting in Boston requires approximately 100 tons of shipping (Figure 6). The vast majority of the shipping consists of goods coming from the Los Angeles market, with the remainder consisting of items flown in from other parts of the country.

When filming in Vancouver, a \$300 million dollar production has a shipping value of 44 tons (Figure 6). Due to the mature film community in Vancouver, there is a wider availability of production items on location. However, all items, such as props, certain set pieces, and costumes, needed for continuity of production are shipped from Los Angeles.

When shooting a \$300 million dollar production in Los Angeles, five tons of shipping is budgeted (Figure 6). This value represents items being shipped to Los Angeles from other locations, which are necessary for the production.

#### t CO<sub>2</sub>e Due to Flights

When calculating the t of carbon on all flights, a 1.89 multiplier is used due to radiative forcing. Radiative forcing is the increased effect of flight emissions on global warming due to the release of greenhouse gases higher in the atmosphere (Stockholm Environmental Institute, Greenhouse Gas Management Institute, 2011).

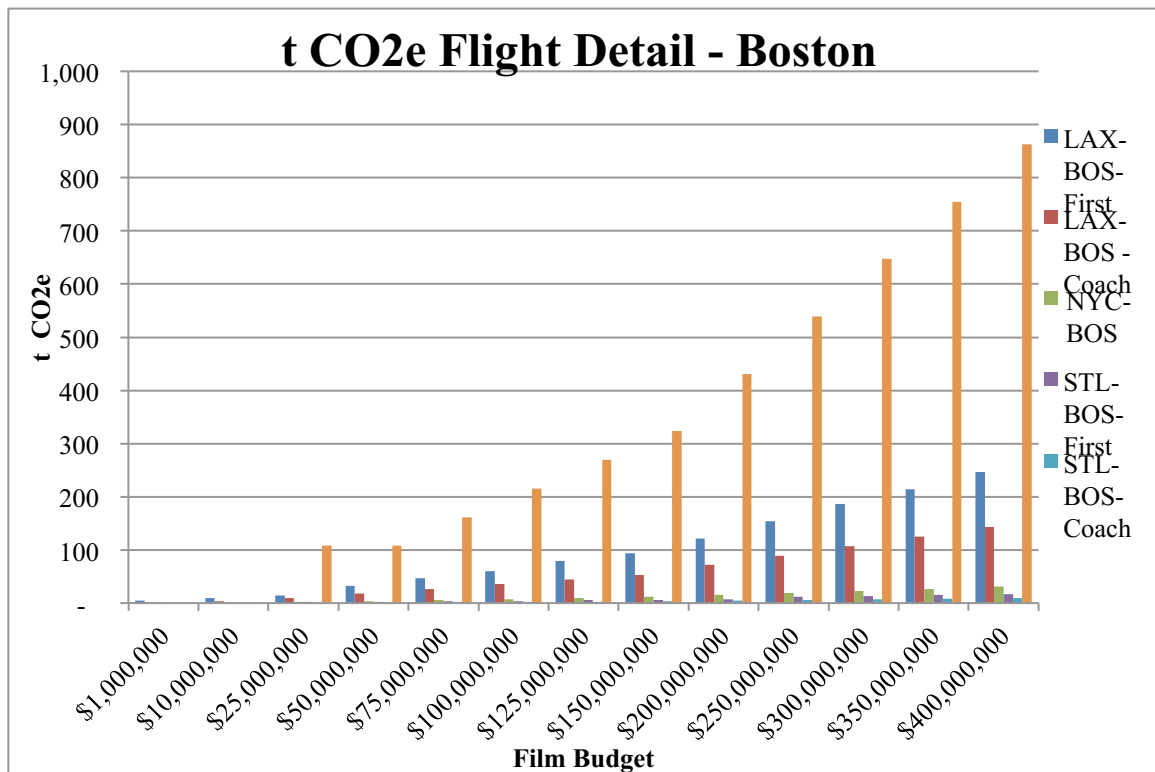


Figure 7. t CO<sub>2</sub>e projections based on flights for Boston production. The orange color represents private (corporate) jet CO<sub>2</sub>e.

As shown in Figure 7, the t CO<sub>2</sub>e has large values resulting from private jet usage.

A \$300 million dollar film budget results in over 600 t CO<sub>2</sub>e due to private jet usage.

The combined t CO<sub>2</sub>e for all flights generate approximately 1000 t CO<sub>2</sub>e for flight activity.

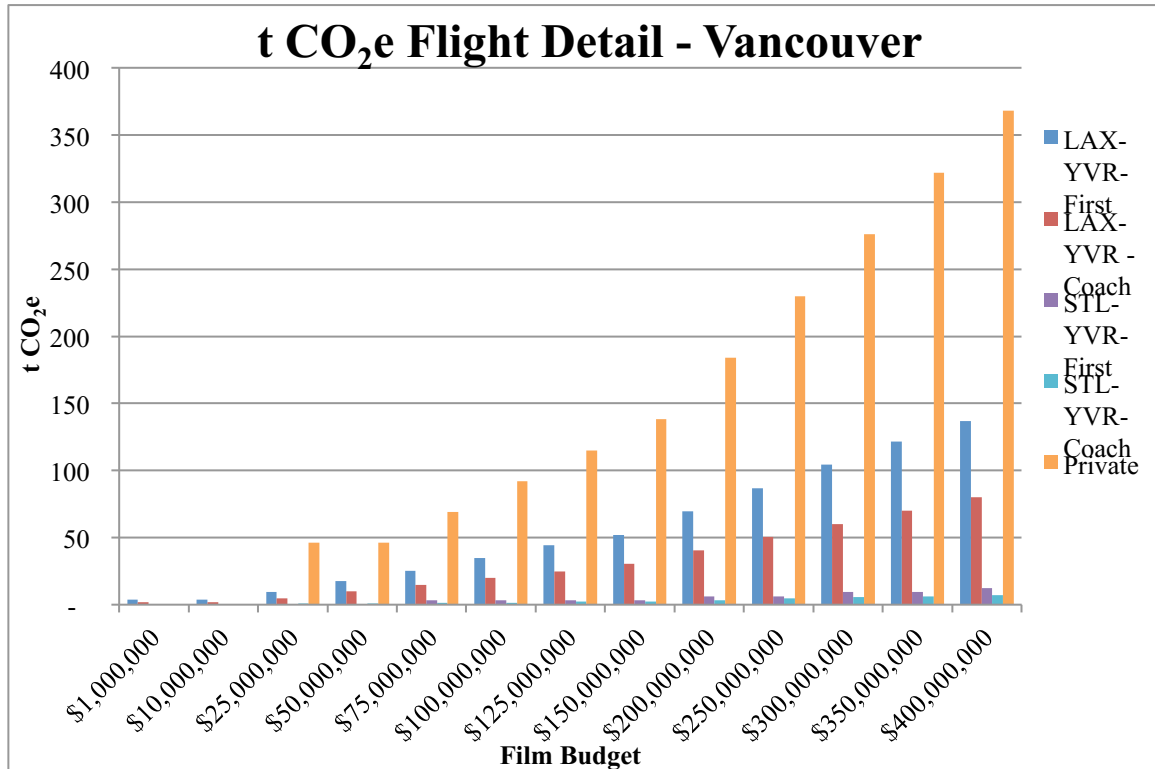


Figure 8. t CO<sub>2</sub>e projections based on flights for Vancouver production.

The flight detail of Vancouver exhibits the impact of private jet usage (Figure 8).

The amount of t CO<sub>2</sub>e emitted more than doubles when private jet usage is added. The private jet usage is budgeted due to studio corporate executives and producers being primarily in the Los Angeles market and utilizing private jet transportation to visit the production.



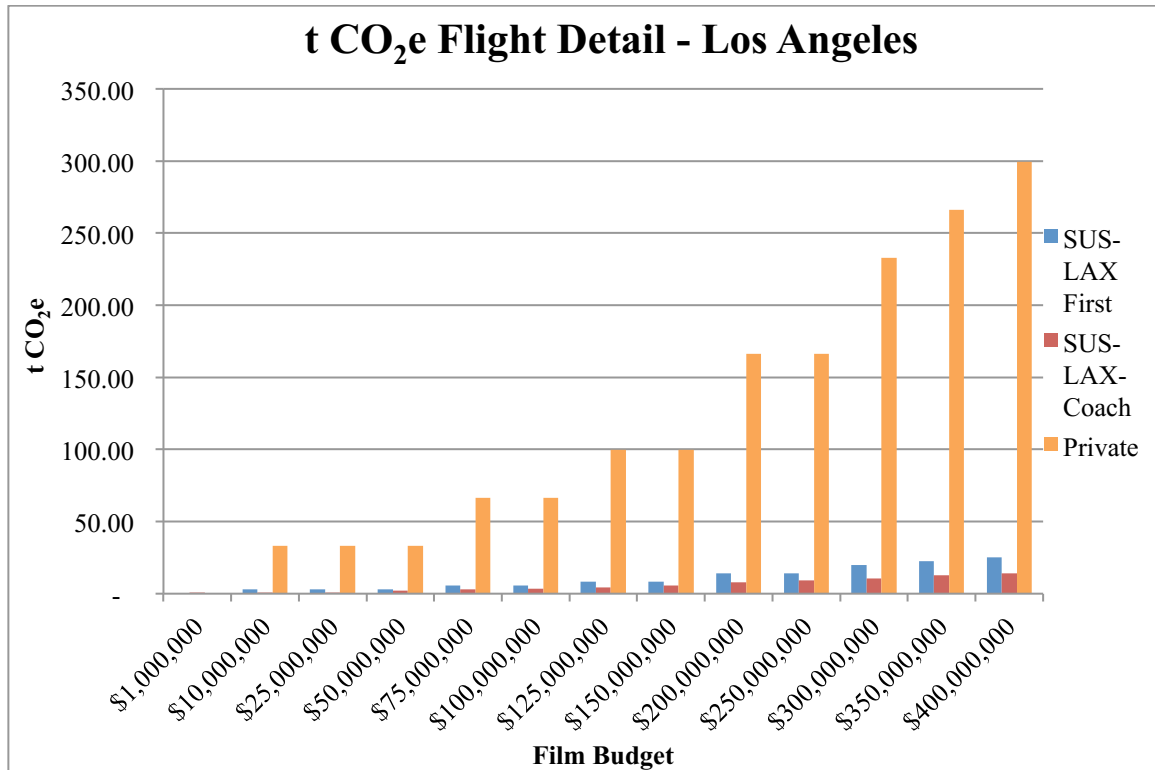


Figure 9. t CO<sub>2</sub>e projections based on flights for Los Angeles production.

As seen in Figure 9, the t CO<sub>2</sub>e emitted for flight activity for a \$300 million dollar production filming in Los Angeles is over 250 due to talent, executives and producers who do not live in the Los Angeles market. The people involved in a Los Angeles production who live outside of the market are the top tier of talent, requiring first class or private jet flight accommodation.

#### t CO<sub>2</sub>e for Corporate Flights

While private (also referred to as corporate) flight transportation is included in the flight data, its significant contribution to greenhouse gases needs to be viewed on its own.

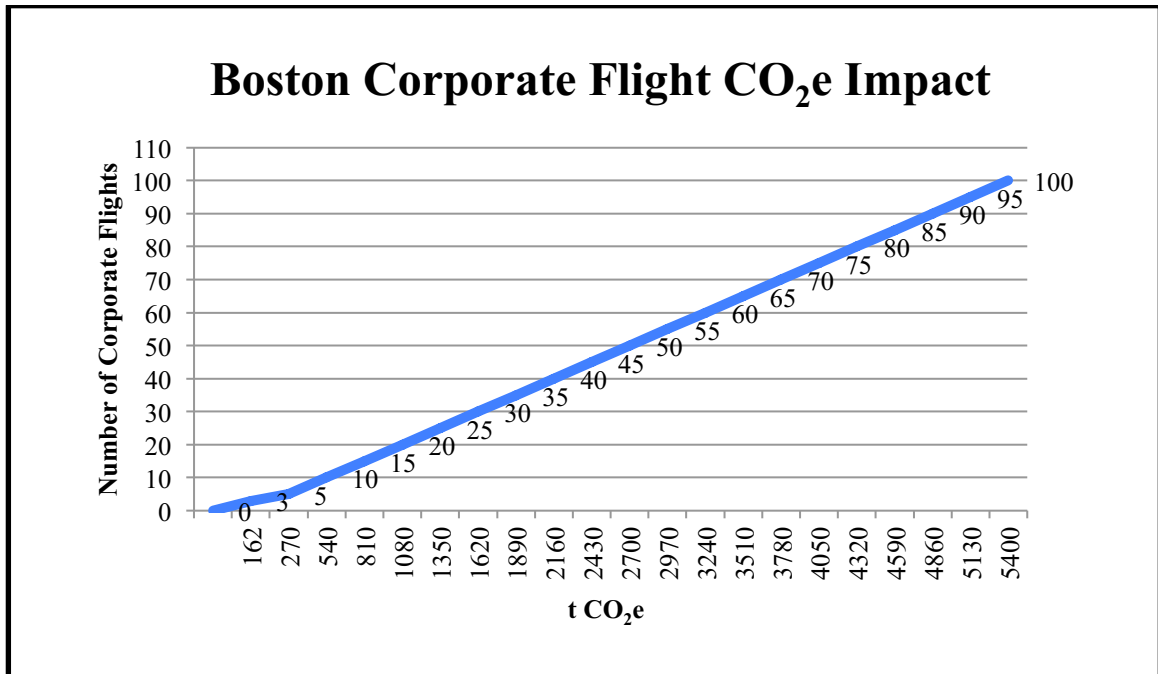


Figure 10. t CO<sub>2</sub>e due to corporate flights for a Boston production.

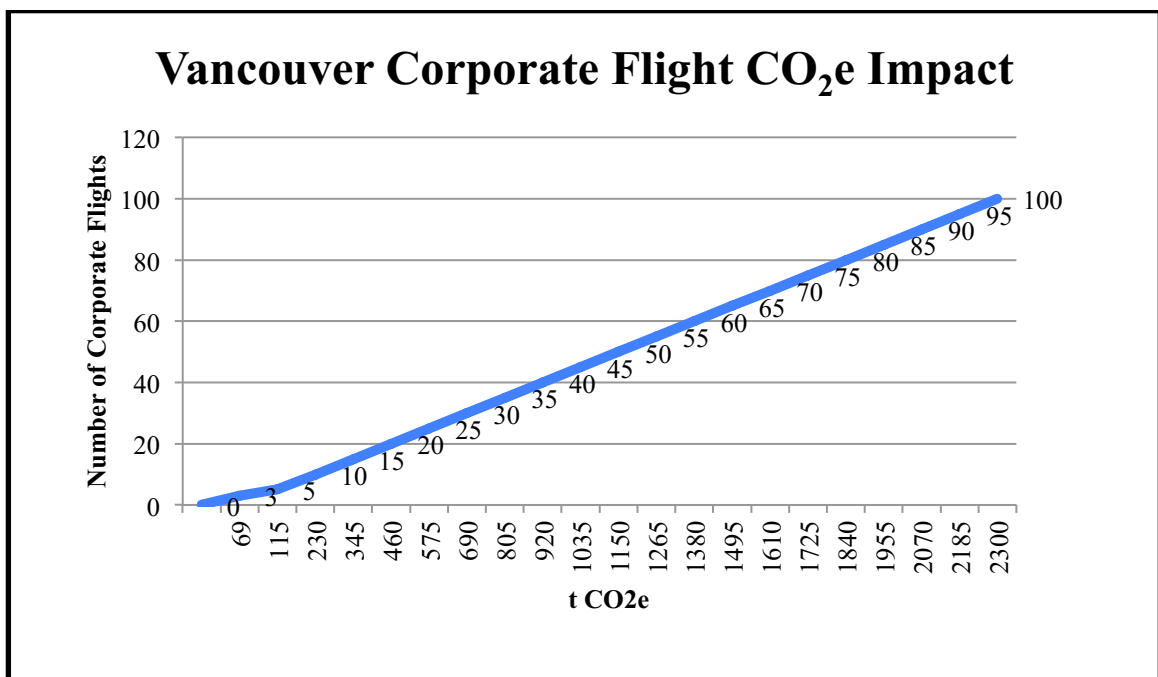


Figure 11. t CO<sub>2</sub>e, due to corporate flights, for a Vancouver production.

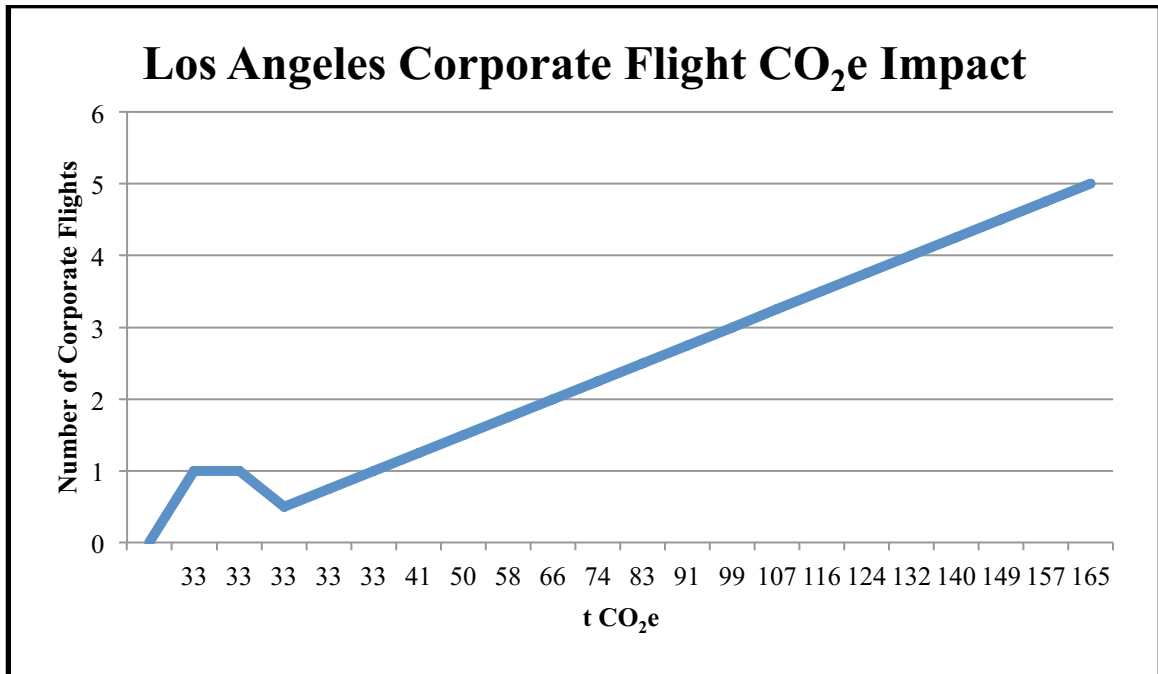


Figure 12. t CO<sub>2</sub>e, due to corporate flights for a Los Angeles production.

In Figures 10, 11 and 12, the correlation between the number of private jet flights taken and the increase of t CO<sub>2</sub>e from such activity is shown. A Boston production with 15 private jet round trips will amount to more than twice the t CO<sub>2</sub>e than 15 private round trips for a Vancouver production due to the proximity to Los Angeles. Further, when considering the Boston production site, three corporate jet round trip flights (based on a Gulfstream 500 aircraft) accounts for more tons of carbon than does all of the production shipping. The Vancouver production has approximately five times the carbon emissions from corporate jet travel as it does for shipping. While Los Angeles has far less in number of flights and shipping than Boston and Vancouver, its t CO<sub>2</sub>e exceeds 350, due to corporate jet flights.

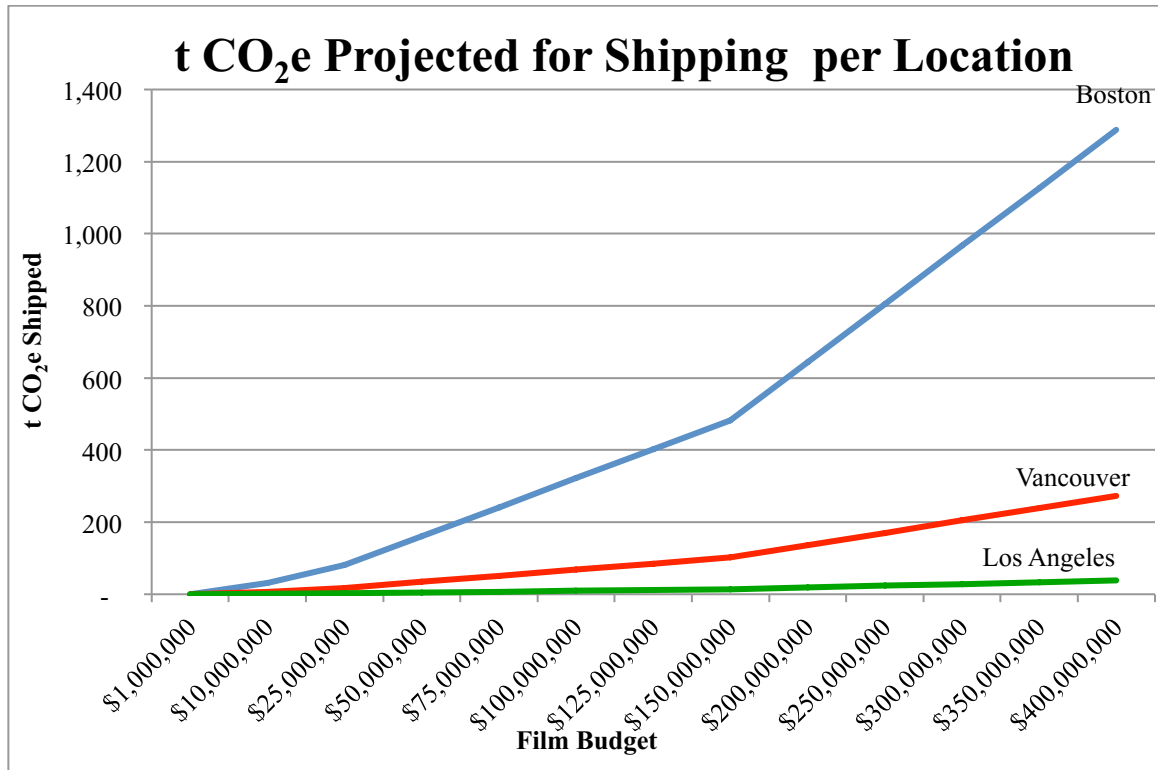


Figure 13. Metric tons of CO<sub>2</sub>e projected for shipping per location.

As with the flight segments, shipping for a Boston production results in the highest t CO<sub>2</sub>e emitted for the three locations, as shown in Figure 13. Vancouver is lower, due to amount of pounds shipped being less than Boston and due to the distance being less than Boston. Los Angeles has the lowest t CO<sub>2</sub>e because less is being shipped to Los Angeles. All of the studios being considered are based in the Los Angeles market, where the costumes are housed, the make-up is housed and there are many existing sets, props, etc.

#### Total t CO<sub>2</sub>e per Market/Greenhouse Gas Emissions Comparison

As shown in Figures 14, 15 and 16, combining the total t CO<sub>2</sub>e for flights and shipping per market for a \$300 million dollar film, indicates a range of less than 300 t

CO<sub>2</sub>e for Los Angeles to approximately 2000 t CO<sub>2</sub>e for Boston, with Vancouver in the middle at 660 t CO<sub>2</sub>e.

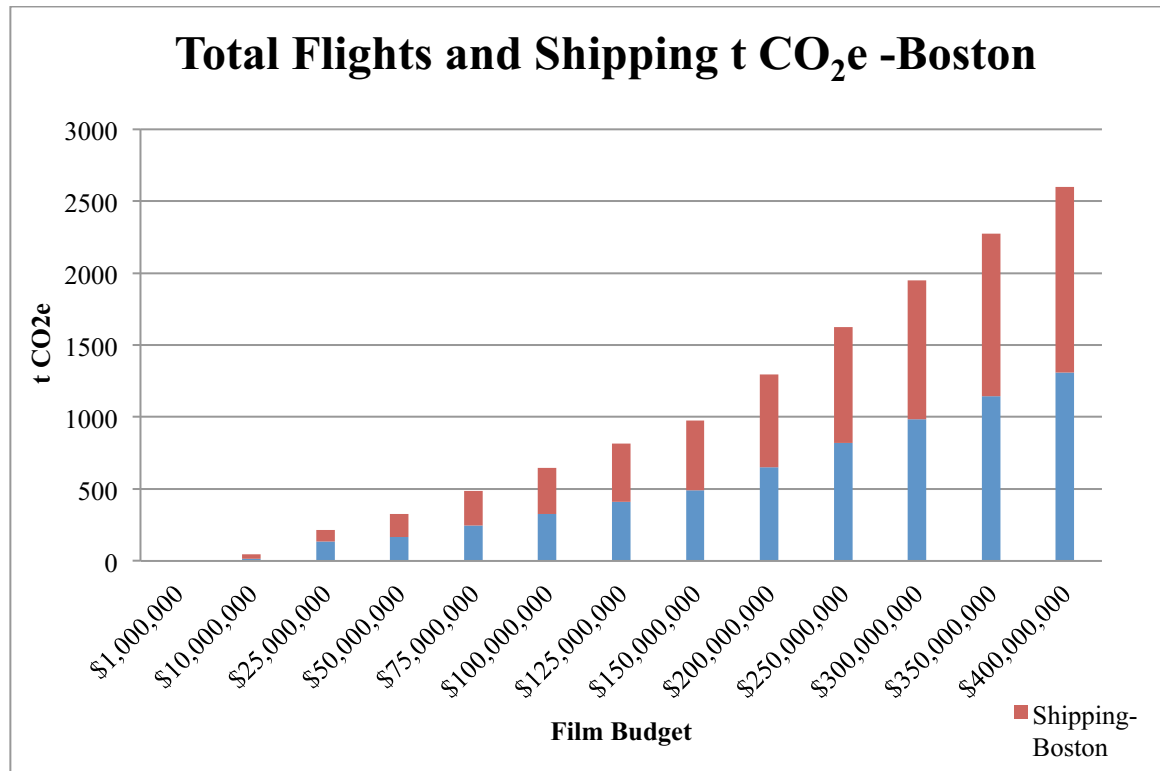


Figure 14. Total t CO<sub>2</sub>e projected for flights and shipping for Boston production.

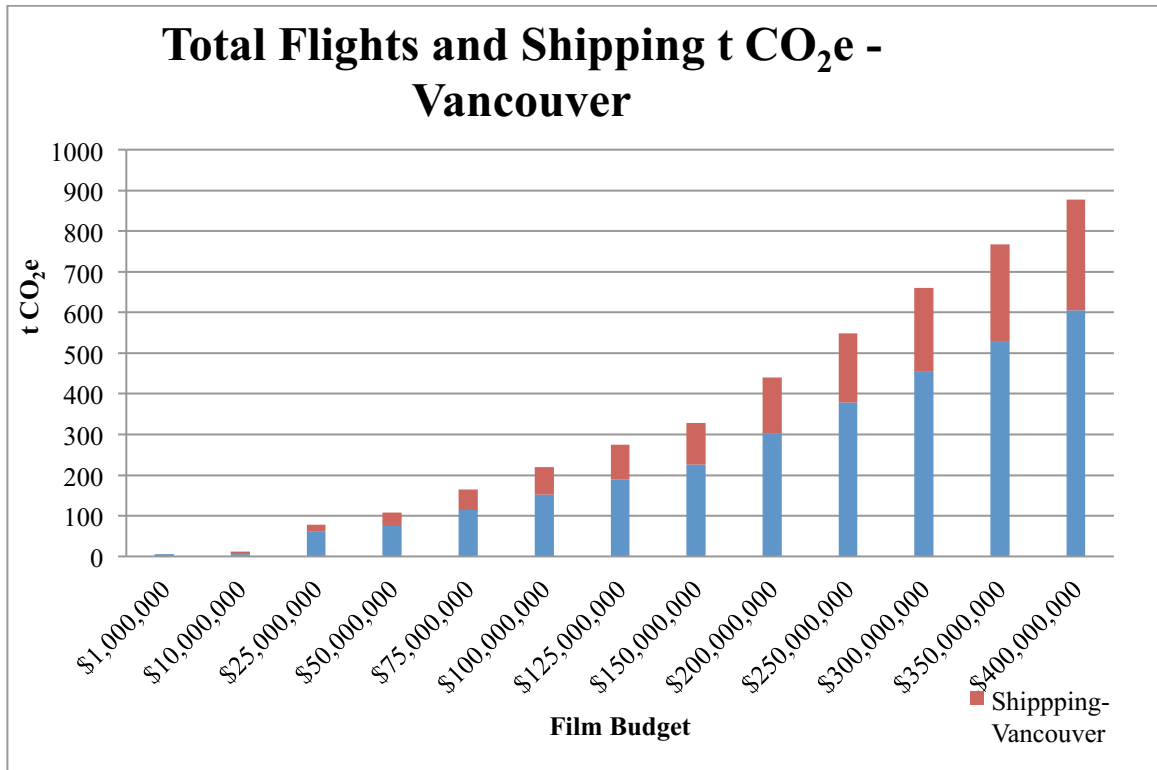


Figure 15. Total metric tons of CO<sub>2</sub>e projected for flights and shipping for Vancouver.

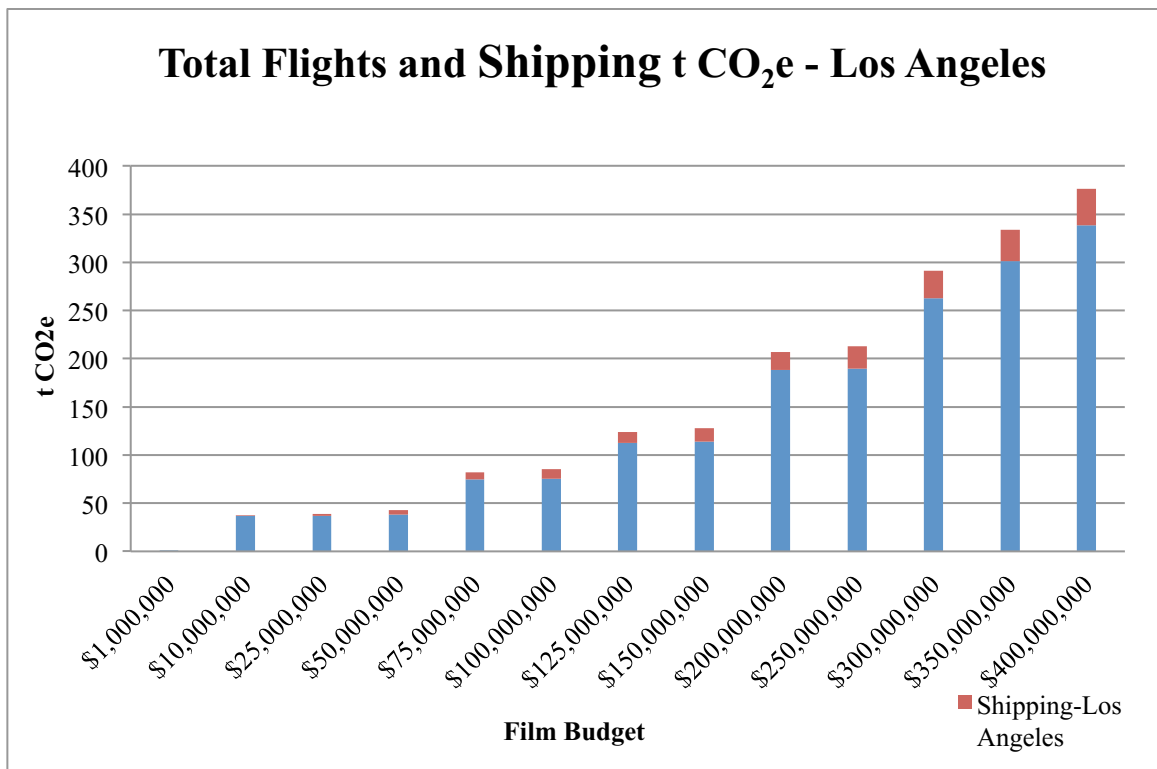


Figure 16. Total t CO<sub>2</sub>e projected for flights and shipping for Vancouver.

## Monetary Value of CO<sub>2</sub>e for Flights and Shipping

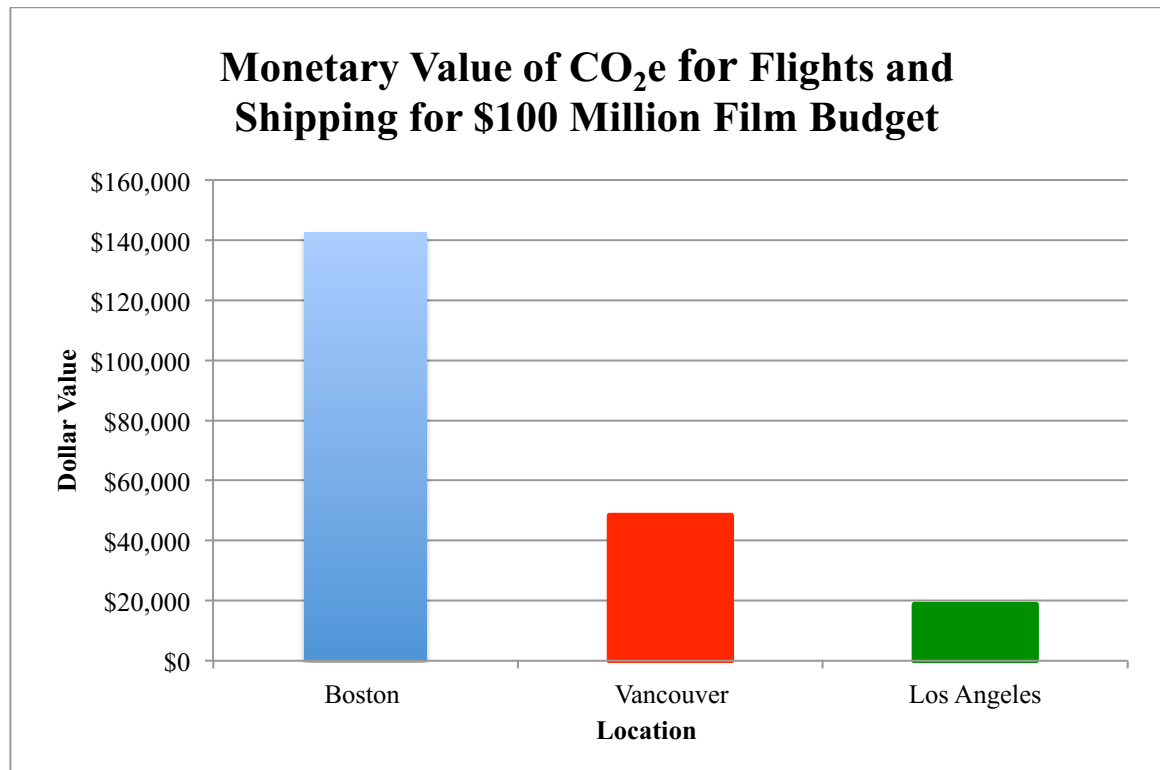


Figure 17. Monetized CO<sub>2</sub>e for flights and shipping for \$100 million film budget.

There is a dollar cost for the t CO<sub>2</sub>e emitted from combined flights and shipping, which increases as the production is moved from Los Angeles to Vancouver, and further increases when the production is moved to Boston (Figure 17). While the numbers portrayed in Figure 17 reflect monetizing CO<sub>2</sub>e by only line item budgeted flights and shipping, adding the entire scope of the production would greatly increase the number. However, even if the number is found to be greatly increased in future studies, the dollar amount does not amount to a large percentage of the film budget, nor of the state and country incentive to film outside of California.

## Chapter IV

### Discussion

These results indicate that, considering just flights and shipping, the top six film production studio productions taken out of the Los Angeles area increase the t CO<sub>2</sub>e emissions in comparison to filming in the Los Angeles market. Boston realizes larger emissions in comparison to Vancouver, due to both the distance from the major studios and the film production infrastructure in Vancouver.

### Conclusions

When the major film studios in Los Angeles take film production outside of the Los Angeles market, the number of people flying increases, as does the amount of round trip flights. Also, the amount of goods shipped to a location outside of Los Angeles increases. Both number of flights and weight being shipped increase when comparing Boston to Vancouver, due to distance from Los Angeles and due to the established film production center in Vancouver.

The number of flights taken and the amount of weight shipped, increase the t CO<sub>2</sub>e. The type of flights traveled also had increased impact on the CO<sub>2</sub>e emitted. Corporate jet travel, even in minimal round trip numbers, greatly increased the CO<sub>2</sub>e values. Filming in Boston has the largest number of t CO<sub>2</sub>e, followed by Vancouver. Filming in the Los Angeles market produces the lowest value of t CO<sub>2</sub>e when comparing the three markets.



## Research Limitations and Assumptions

The research has limitations and assumptions, which limit generality about specific values. First, the base film used to compare the three locations, was not actually filmed in those locations. The average cost to produce a film stopped being reported by the Motion Picture Association of America in 2007. Since that time, budgets have been harder to confirm. However, analyzing the top 1000 films produced, and separating 2014 and 2015, the average Hollywood film was above \$100 million to produce (The Numbers, 2016). The tons of carbon emitted increases with the film production budget. Most often, films are not produced in one location. When filming in various locations, all people and goods must be transported to each of the locations, resulting in a multiplier for the metric tons of carbon dioxide emitted per film. The values in this study represent only one location shoot.

The flight and ground travel and shipping is based on an approximately \$75 million dollar budget film's actual line item budget. The assumption is that the "base" information derived from the \$75 million dollar film will have an inverse relationship as the budget of the film decreases and a proportionate increase as the film budget increases. The assumptions are used in the three location scenarios. However, film production is not predictable. Each production may require a drastically different number of personnel or shipping. For instance, a period piece may require a higher than proportionate increase for shipping, due to heavy costumes and props. Or, a film may require a larger number of actors than another production. The base film used does not take such circumstances in to account. When comparing the amount of private/corporate jet round trip flights per production, the approximately \$75 million dollar line item budget had three budgeted.

That number was then extrapolated to estimate the number of private/corporate jet round trip flights for the other production values. However, the actual number of private/corporate jet round trip flights flown during a production, are most likely significantly higher. For instance, the feature film, *The Butler*, was approximately a \$30 million dollar budgeted production (IMDB, 2016). That film had 39 producers, who are most likely to be utilizing the studio private/corporate jet. The amount of round trip flights taken on the private/corporate jets would most likely have exceeded the approximately 2 round trip flights, derived from the base budgeted film.

Second, the flight and shipping data does not include any of the line items outside of the budget for contractors, executives or investors. The flight data also does not include family members or personal assistants of personnel budgeted flights. Adding each of those categories of personnel would also increase shipping.

Third, best efforts were used to examine each production budget line item of the film to determine a baseline for shipping. Baseline information of approximate weight of goods shipped was assigned based on financial information from the actual base film. All assumptions were applied consistently to each of the three situations.

Fourth, there is no way to know the exact number of personnel or weight of goods that would be commissioned locally on a production. Again, best efforts were given to determine number of personnel and weight of goods, per location. Industry norm was used to determine the percentage differences in flights and shipping for each location.

Last, different studios utilize different practices, which were not taken in to account. A studio may have unknown sustainability practices, which will not be reflected

in this research, such as, if a studio flies the corporate jet in lieu of a portion of budgeted first class flights.

Therefore, the totals shown are lower than the expected flight and shipping calculations for an actual film produced in the three locations. Also, the actual t CO<sub>2</sub>e emitted for a complete film would have higher levels not depicted in this research. This research does not include the full Scope 1, 2, and 3 of the production of the film, as it is beyond the scope of this thesis.

Despite these limitations and assumptions, the research results are robust in predicting that the t carbon emitted increases with the film production budget, and locations outside of Los Angeles will engender larger carbon footprints from added flights and shipping, and their distance. When filming in various locations, all people and goods must be transported to each of the locations, resulting in a multiplier for the t carbon dioxide emitted per film.

## Recommendations

Studios do not need to cease major film productions outside of the Los Angeles markets. However, there are steps the studios can take to decrease the negative environmental impact of those decisions.

Locations luring the studios could require minimal information to be used to calculate a portion of the carbon footprint. Calculating the t carbon emitted for flights and shipping is a simple task for a state or country, and incentivizing the production could be require sharing the budgeted flights and shipping information. The state or country where the film is being shot would then calculate the tons of carbon emitted. The

studio would then be provided with the number and could be required to offset the carbon. While purchasing carbon credits is not ideal, it has an advantage over the current programs, which require no proof of efforts for decreasing carbon emissions.

In order for a production to shoot out of state or out of the country, flights are necessary for people and goods. The impact of greenhouse gas emissions at a high altitude has larger implications than those emissions released the other aspects of production, such as increased ground transportation. As further stated in a study on flight emission data (Wilkerson, Jacobson, Malwitz, Balasubramanian, Wayson, Fleming, Naiman, & Lele, 2010):

The potential impacts of aviation on climate are unique since most of the emissions occur at altitudes where other anthropogenic sources are absent. The effects of aviation on stratospheric ozone and global climate from persistent contrails and contrail-induced cirrus clouds could be significant, but there are large uncertainties in relating aviation emissions to changes in radiative forcing or surface temperature from contrail-associated pathways.

Since the largest contributor in the flight and shipping categories is the private/corporate jet use, significant greenhouse gas decreases are possible by requesting executives fly commercial flights. Executives flying first class will emit less greenhouse gases than flying on the corporate jet.

Also, many of the people who fly to and from the production site are not integral to the actual production. Some studio executives and financial investors, for instance, travel to the location for verification of quality of production or for entertainment. Many times these individuals take corporate jets, greatly increasing the greenhouse gas emissions associated with the production. Furthering the negative environmental impact, many of those flights are not associated with the actual budget of the film because they

are paid outside of the film budget. Limits could be set, requiring transparency as to how many flights were taken; those flights would be included in the production carbon assessment.

Non-integral trips associated with the production could be replaced by the ever-improving video options. Hand held devices do not give a feeling of being immersed in the experience. A person on set walking around with a handheld device will not give executives or investors a real feeling of being on the set. However, 3-D video conferencing technique is a real possibility today. Microsoft has existing technology, called kinect sensors, which interact with mirrors and a camera, allowing a 3-D video conferencing experience utilizing cylinders for display (Microsoft, 2016). As seen in Figure 18, the person utilizing the technology can see, and be seen, the full 360 degrees, providing a real sense of “walking the set.”



Figure 18. Image of 3-D video technology (Jablonski, 2012).

It is possible the 3-D technology is not currently utilized because the technology is not yet 100% accurate. If that is the case, major film studios have progressive technology departments to support the film effects used on major productions. Those same technology departments could work with the current 3-D video conferencing companies to help further the technology. Furthermore, the cost of each video conferencing pod is approximately \$5000 (Boxall, 2012). Financial breakeven would occur after cost savings from as little as two first class tickets, and yet the benefits of the pods would continue throughout future productions.

In summary, the recommendation that studios provide very basic flight and shipping data should be a minimum requirement when incentivizing a studio to produce a film out of state or out of the country. In return, a simple direct debit from the

incentive could be deducted to offset the greenhouse gases emitted for the production.

This would be a minimal dollar amount in comparison to the production budget.

Furthermore, if the studios calculate a film's individual greenhouse gas emissions, those calculations should be submitted to the state or country providing the incentive.

Conversely, a state or country providing incentives should require studios to provide emissions information, and require carbon-offsetting payment to the state or country.

Having a requirement of transparency, requiring a studio to provide flight and shipping information, would enable state and country incentive bodies to include greenhouse gas emissions as part of the decision making process.

Further study is needed to determine the actual greenhouse gas emissions for individual films. Each film varies so drastically. Ongoing greenhouse gas emission standards and reporting for film production should be researched in future studies.

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